SYLLABUS & PROGRAMME STRUCTURE

Physics

(Honours)

(Choice Based Credit System)

(Effective from the Academic Session 2017-2018)

Sixth Semester

MAHARAJA BIR BIKRAM UNIVERSITY
AGARTALA, TRIPURA: 799004

PROGRAMME STRUCTURE

Structure of Proposed CBCS Syllabus B.A / B.Sc / B.Com Honours

Semester	Core Course (14) Honours	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
1	**C1** **C2**	**AECC1: Environmental Science**			**GE1** (Paper-I of selected subject other than Hons subject)
2	**C3** **C4**	**AECC2 : (English/MIL (Communication)**			**GE2** (Paper-II of selected subject other than Hons subject)
3	**C5** **C6** **C7**		**SEC1**		**GE3** (Paper-III of selected subject other than Hons subject)
4	**C8** **C9** **C10**		**SEC2**		**GE4** (Paper-IV of selected subject other than Hons subject)
5	**C11** **C12**			**DSE1** **DSE2**	
6	**C13** **C14**			**DSE3** **DSE4**	

Semester-VI
PHYSICS (Hons) CC- Paper- XIII
ELECTROMAGNETIC THEORY

(Credits: Theory-04, Practicals-02)
Marks: Theory-70 (60 + Inter: 10), Practical-30 (20 + Inter: 10)
Theory: 72 Lectures

Unit-I[15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Maxwell's Equations and EM wave propagation:

Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media.

Displacement current, Maxwell's electromagnetic equations, propagation of plane electromagnetic waves in isotropic dielectric medium and free space,Transverse nature of plane EM waves, Refractive index, wave impedance, polarized electromagnetic wave, Poynting vector, Poynting Theorem, energy density in electromagnetic field, Electromagnetic Energy Density. Physical concept of electromagnetic Field Energy density. , Momentum Density and Angular Momentum Density.

Unit-II [15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Reflection and Refraction of Electromagnetic Waves:

Reflection and Refraction of a Plane Wave at a Plane Interface between Di-electrics. Fresnel Formulae for perpendicular and parallel polarization cases, Total Internal Reflection. Brewster's Angle. Reflection and Transmission coefficients, Waves in Conducting Media-skin effect and skin depth.

Equation of motion of an electron in a radiation field, radiation damping (formula to be assumed), Cauchy and Sellemierequation, Lorentz theory of dispersion – normal and anomalous

Unit-III [15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Polarization of Electromagnetic Waves:

Description of Linear,Circular and Elliptical Polarization. Propagation of e.m. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary and Extraordinary Refractive Indices. Production and Detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

Unit-IV [15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Rotatory Polarization, wave guides and fibre optics :

Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of Optical Rotation. Calculation of Angle of Rotation. Experimental Verification of Fresnel's Theory. Specific Rotation. Laurent's Half-Shade Polarimeter.

Wave Guides: Planar Optical Wave Guides. Planar Dielectric Wave Guide. Condition of Continuity at Interface. Phase Shift on Total Reflection. Eigen value Equations. Phase and Group Velocity of the Guided Waves. Field Energy and Power Transmission.

Optical Fibres: Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres. Applications.

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Reference Books:

1. Introduction to Electrodynamics, 3rd edition, By David J. Griffiths,
2. Electromagnetics by B.B.LAUD, Wiley Eastern Limited
3. Fundamentals of electricity and magnetism by Basudev Ghosh, Books and Allied (p) Ltd.
4. Applied electromagnetism Introduction to Electrodynamics by A.Z.Capri&P.V.Panat.(New Delhi: NarosaPub.House, 2002). 5. Electromagnetics by Joseph A.Edminister 2nd ed.(New Delhi: Tata Mc Graw Hill, 2006).
6.Fundamentals of electromagnetics by M.A.W.Miah.(Tata Mc Graw Hill,1992)
7. Applied electromagnetism By Liang Chi Shen, Jin Au Kong (PWS Pub. Co., 1995)
8. Classical Electrodynamics, 3rd edition, (Wiley, New York 1998)
9. M. Lifshitz and L. D. Landau, 10.Classical Theory of Fields (Course of Theoretical Physics), 2nd Edition, (Pergamon Pr; 1981).
10. Electricity and Magnetism, D Chattopadhyay and PC Rakshit, Books and Allied(P) Ltd. (2001)

PHYSICS PRACTICAL-CC XIII LAB

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (KeroseneOil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection usingWollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internalreflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing anglefor air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junctiondiode.

Reference Books

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, AsiaPublishing House.
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers
• A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
• Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Semester-VI
PHYSICS (Hons) CC- Paper- XIV
STATISTICAL MECHANICS

(Credits: Theory-04, Practicals-02)
Marks: Theory-70 (60 + Inter: 10),Practical-30 (20 + Inter: 10)
Theory: 72 Lectures

Unit-I[15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Black Body Radiation, Classical and Quantum Theories of Radiation:
Perfectblack body, Black body radiation and its analogy with ideal gas, Kirchhoff'sLaw, Stefan-Boltzmann law, Radiation pressure and their simple derivation.Spectral Distribution of Black Body Radiation. Experimental results, Wien's Verification.Displacement and distribution law, Ryleigh-Jeans law, Ultraviolet catastrophe, Planck'squantum hypothesis, Planck's law of black body radiation—it's derivation. Deduction of (1) Wien's Distribution Law,(2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

Unit-II [15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]
Basics of Classical Statistical Mechanics,Partition function and its application:
Macrostate& Microstate, Elementary Concept of Ensemble, Phase Space, thermodynamic Probability and Entropy, Boltzmann theorem, Maxwell-Boltzmann Distribution Law, Partition Function and its importance. It's application to ideal gas:i) MB distribution function for monoatomic idealand electron gas, ii) Equation of state, iii) internal energy, iv) entropyand molar specific heat, v) Maxwell's energy and speed distribution law. Classical Entropy Expression, Gibbs Paradox and it's resolution, Sackur Tetrode equation, Law of Equipartition of Energy and its proof, Applications to Specific Heat and its Limitations.

Unit-III [15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]
Bose-Einstein Statistics: Introduction to quantum statistics, Boson and Fermions,B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Boltzmann limit for Boson systems, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Unit-IV[15 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]
Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Boltzmann limit for the fermion systems, Electron gas in a Metal, Electrical and thermal conductivities, Specific Heat of Metals,Richardson-Dushman equation for thermionic emission.

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2^{nd} Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill •Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.

- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

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PHYSICS PRACTICAL-C XIV LAB

Use Scilab/ C^{++} for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

N.B. It is advised to do the practical in Scilab only.

Reference Books:

- Elementary Numerical Analysis, K.E.Atkinson, 3 rd Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 9786133459274

Semester-VI
PHYSICS(Hons)-DSE III: Classical Dynamics

(Credits: Theory-05, Tutorials-01)
[Marks: Theory- 80, Tutorial- 20] Theory: 80 Lectures

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Unit-I [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Classical Mechanics of Point Particles: System of particles, Its expression for force, angular momentum, energy; Generalized coordinates and velocities, concept ofLagrangian, D Alembert's principle and the Euler-Lagrange equations.Lagrangian equation of motion: holonomic system, non-holonomic system, conservative system; Application to simple systems. Canonical momenta and Hamiltonian. Hamilton's equation of motion. Application: Hamiltonian for a harmonic oscillator, particle in a central force field. Hamilton's principle, Poisson brackets. Canonical transformation.

Unit-II [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Special Theory of Relativity: Lorentz Transformations. Makowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time –dilation, length contraction and twin paradox. Variation of mass with velocity (head-on and oblique collision), Equivalence of mass and energy. Four-vectors: space like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy –momentum relation. Doppler effect from a four-vector perspective.

Unit-III [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Relativistic theory and electromagnetism: Concept of four –force. Conservation of four momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. The electromagnetic field tensors and its transformation under Lorentz transformation: relation to known transformation properties of **E** and **B**. Electric and Magnetic fields due to a uniformly moving charge. Equation of motion of charged particle and Maxwell's equation in tensor form. Motion of charged particles in external electric and magnetic fields.

Unit-IV [17+3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, smallamplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) -identicalsprings.

Fluid Dynamics: Density and pressure in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Navier-Stokes equation, qualitative description of turbulence,Reynolds number.Incompressible and compressible flows, laminar and turbulent flows, rotational and irrotational flows. Separated and unseparated flows. Flow visualization-streamline, path lines, streak lines (qualitative discussion only)

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Reference Books:

- Mathematical Physics, B.S Rajput, 8th Edn., Pragati Prakashan (1978)
- Mathematical Physics, B.D Gupta, 4th Edn., Vikas Publishing House
- Fluid Mechanics, 2nd Edition, L.D. Landau and E.M. Lifshitz, Pergamon Press, Oxford, 1987
- Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education .
- Classical Mechanics: An introduction Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press.

Semester-VI
PHYSICS (Hons.)-DSE IV
Nano Materials and Applications

(Credits: Theory-05, Tutorials-01)
[Marks: Theory- 80, Tutorial- 20]   Theory: 80 Lectures

Unit-I [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1Dnanostructures and its consequences.

(12Lectures)

ELECTRON TRANSPORT: Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level andsurfacedefects.**(8 Lectures**)

Unit-II [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD).Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. BE growth ofquantum dots.**(10Lectures)**
CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning TunnelingMicroscopy.**(10 Lectures)**

Unit-III [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure.Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructuresand nanostructures.

(20Lectures)

Unit-IV [17 +3 (Intro.+ Recap. + Problem hints/ Practice) Lectures]

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots-magnetic data storage. Micro Electromechanical Systems (MEMS), Nano ElectromechanicalSystems(NEMS).

(20 Lectures)

N.B: Simple Problems (covering Unit-I, II, III & IV) using formulae of these respective units to be practiced.

Reference books:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt.Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital PublishingCompany)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning PrivateLimited).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge UniversityPress.
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley andSons).